National Aeronautics and Space Administration

Nano Launch 1200:

MSFC's Role and Vision for Small Launch Vehicles

16th Annual Space & Missile Defense Symposium

August 14, 2013

marshall

Jonathan Jones/PI
Pat Lampton/Co-PI

Dr. Lisa Watson-Morgan
Acting Associate Director, Technical
Engineering Directorate

Small Launch Vehicles

- Reduce the cost of launching a small payload or nanosat (1 – 10kg) to space
- Employ latest manufacturing technologies such as additive manufacturing to reduce costs of complex parts
- Enable Technology Readiness Level progression through access space (i.e., enable flight demo within Phase 2 SBIR scope)
- Early career personnel development opportunity with mentors to gain valuable hands on project experience
- Combines MSFC's propulsion core capability with the increasing need for low cost, quick access to space for payloads such as nanosats
- Demonstrate rapid design, flexibility with art to part

Affordability is Key

- 1200 refers to dollars in K's
- The case and dome are titanium (Ti6Al4V) printed using electron beam melting
- Plan is to put 4kg in orbit for under $1M; goal of $250K per launch after 10 successful
- Performance can be adjusted
- Project has multiple phases that can be adjusted based on funding profile

PSRM-10 Static Test #1 – Oct 2012

Printable Rocket

Performance to 200 km Circular, 28.5 deg inclination

Payload = 13 lb
Shroud = 5.5 lb
Max Q = 4600 psf
Max G, boost = 10
Max G, overall = 26

Currently testing 3rd and 4th printed stages

2nd Successful Static test firing of PSRM pathfinder (PSRM-10) July 2013

Nihka

Peregrine or Black Brandt
Black Brandt

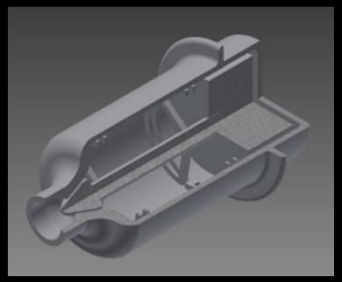
Vehicle Sizing	1st Stage	2nd Stage	3rd Stage	4th Stage
Burnout Mass (lb)	610	188	37	9
Propellant Mass (lb)	2243	756	120	28
Specific Impulse(sec)	250	256	288	283
Initial Mass (lb)	4004	1151	207	50
Final Mass (lb)	1761	395	87	22
Diameter (in)	20	17	10	8
Length (in)	210	76	60	18

Partnerships are Key

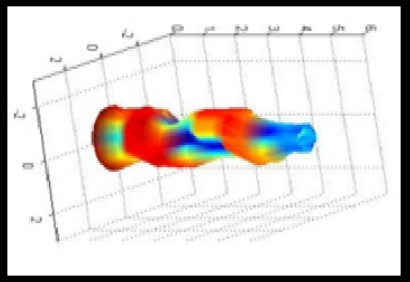
- AFRL performs mix, cast of static test & flight motor
- Ames and KSC partnering opportunity for the avionics
- KSC partnering on ground operations
- GSFC Wallops or KSC partnering opportunity for 2014 and 2015 launches
- University partnerships on technologies
- Open to other partnerships

MSFC Strategy

- Center is investing in new technology areas of additive manufacturing; Project is starting with printed cases
- Evolvability plan includes using the rocket as a test bed for technology infusion
  - Liquid engines, printable propellant, composite tanks, avionics, etc.
- End goal is reduced launch vehicle costs
- Demonstrate rapid design to flight cycle
- Early career employees partnering with a mentor on the project.
- MSFC created an Orbital Launch Vehicle design class using Nano Launch
- Partners are essential
- Plan to hand over to commercial after technologies are proven



Printable valve
With no seals BYU



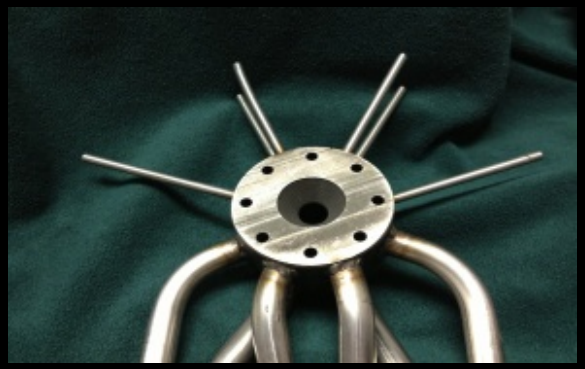
Complex printed grain geometry; low cost ABS plastic fuel – Utah State

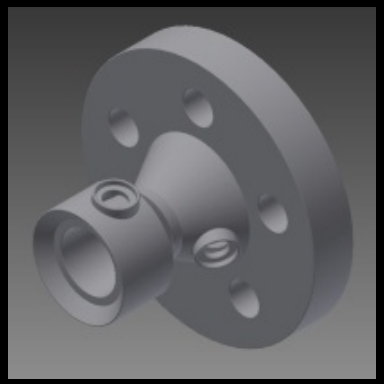
Phase IV: The Path to Nanolaunch 250

- Continue Flying Nanolaunch 1200
- Infuse government IRAD, university, and small business innovation to lower price
- Standardize requirements and interfaces
- Resist the urge to increase performance while sacrificing cost and schedule

A Few Infusion Options:

- Printable liquid engines and stages
- Throttable, printable hybrid
- Unique solid fuel staged combustion
- Lower priced avionics, RCS, etc.



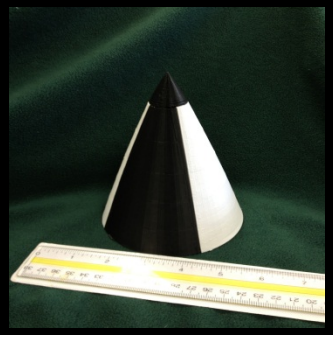


Regeneratively-cooled hybrid nozzle, Univ. of TN

Static Test 100 lbf LOX/Propane

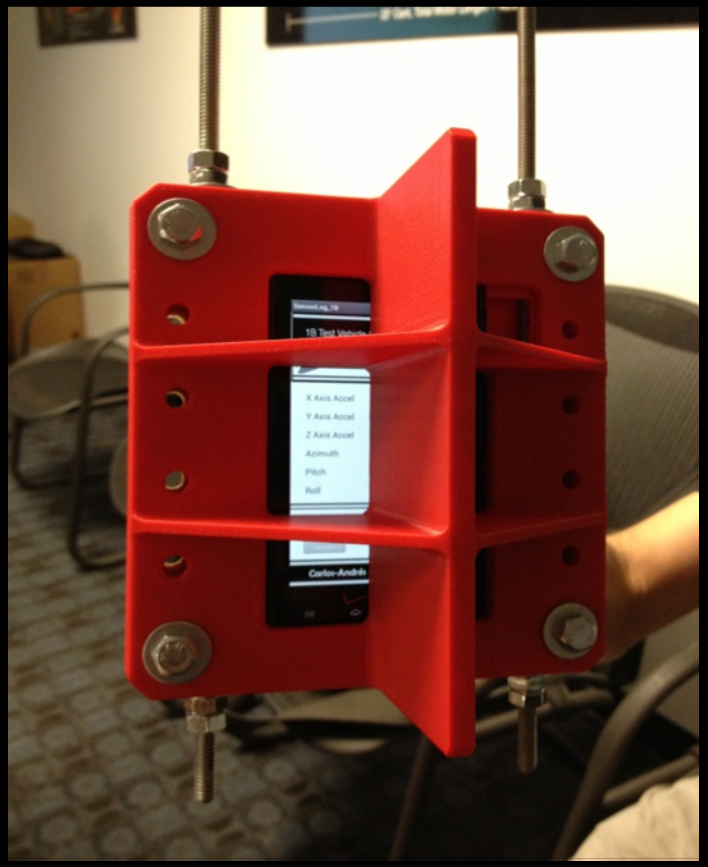
Near Term Activities

- Test 2 stages at altitude August 24, 2013 in Manchester, TN (15,000 to 20,000 ft)
- Test avionics packages in September 2013 at KSC using Pad 39A; will also demonstrate composite case with printed dome (Pathfinder for PSRM-120)
- October 1, 2013, start phase II of the project leading to Suborbital Flight Test with Excess Booster at either KSC or Wallops in August 2014



Nose cone

Near Term Activities



Secondary payload android phone
With custom app

Principle Investigator is Jonathan Jones
Co-Investigator is Pat Lampton

www.nasa.gov/marshall